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# PATENT SPECIFICATION

DRAWINGS ATTACHED

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**849,774**

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## COMPLETE SPECIFICATION

## Improvements relating to Articles consisting wholly or partly of Resilient Cellular Materials

We, DUNLOP RUBBER COMPANY LIMITED, of 1, Albany Street, London, N.W.1, a British Company, do hereby declare the invention, for which we pray that a patent may be granted us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to cushions and other articles consisting wholly or partly of resilient polyurethane foam. By a "resilient polyurethane foam" is meant a resilient cellular material of the kind obtainable by reacting (1) an organic compound of intermediate or high molecular weight or at least of intermediate or high average molecular weight, i.e. 500 to 15000, having two or more isocyanate reactive groupings in its molecule (e.g. a polyester or polyesteramide having hydroxyl and/or carboxyl groups or a polyether having terminal hydroxyl groups), (2) an organic poly-isocyanate (usually a di-isocyanate), and (3) an activating mixture, which usually contains water, and which may also comprise an emulsifying agent and an activating agent proper (e.g. a tertiary amine). The procedure usually followed in producing resilient polyurethane foam consists in mixing the three materials just mentioned, together with any desired colouring agent, hair or other fibrous material, or other additional constituent, allowing the mixture so formed to foam at ordinary room temperatures and then to set at ordinary room temperatures, and allowing the set foam to mature, either at ordinary room temperatures or at an elevated temperature. In maturing, certain cross-linking reactions which take place between the isocyanate-reactive compound "(1)" and the organic polyisocyanate "(2)" are completed, and the product develops the desired mechanical properties. This product generally has a tough leathery skin, which is usually cut off before the material is used to form cushions and so forth. It is with material free from such a skin that the present invention is concerned, and this is referred to below as "trimmed resilient polyurethane foam".

It is an object of the invention to provide a novel method of forming a rounded edge face on a slab of trimmed resilient polyurethane foam, i.e. a body of the material having two main faces substantially parallel with each other and an edge face joining these two main faces.

According to the present invention, a method of forming a rounded edge face on a slab of trimmed resilient polyurethane foam (as defined above) comprises subjecting the material to heat and pressure along a line adjacent to said edge face, the pressure being directed substantially normally to a main face of the slab.

The invention also includes cushions and other articles comprising a slab of trimmed resilient polyurethane foam (as defined above) having an upper main face, a lower main face and an edge face joining the upper and lower main faces and generally convex in cross-section with the apex of the curve at least approximately midway between the upper and lower main faces, characterized by a layer of compressed material lying at the apex of the curve and therefore at the middle of the said edge face or slightly offset therefrom. These articles can be made by the method specified in the preceding paragraph, which has the characteristic that it will form an intermediate compressed layer of the kind just mentioned, this compressed layer extending over the area over which the pressure has been applied.

[P]

The pressure applied to the novel method of forming rounded edge faces on trimmed resilient polyurethane foam may be applied through one or more dies, which may take such forms as a thin straight or curved metal bar, or a combination of such bars, or again a thin-walled metal ring.

It is surprising that the application of pressure in the manner referred to above, i.e. merely along a line, can produce an edge face rounded at both of its boundaries with the main faces, but it is a fact that the procedure specified can produce rounded edge faces which are almost symmetrical; the cross-sections of the rounded edge faces are actually generally similar to the end of an ellipse. Since almost symmetrical rounded edge faces can be obtained, the invention is of particular value in that it can be applied to the production of reversible cushions with rounded edge faces. In this case the die or dies or other means used to apply pressure extend around the entire periphery of the slab of trimmed resilient polyurethane foam from which the cushion is to be formed. Reversible cushions of circular, elliptical or other continuously-curved outline can be obtained using a die in the form of a ring or other closed curvilinear figure, and reversible cushions of square, rectangular, symmetrical trapezium shaped or D-shaped outline can be obtained using a die comprising a number of bars or the like combined into the outline in question.

The trimmed resilient polyurethane foam may be heated by high frequency dielectric heating. The heat is normally applied after the pressure has been applied to the material, and while it is still being kept compressed. The material in question may be supported by a substantially flat platen, and this platen, or any other supporting means used, may either be kept stationary during the pressing operation or moved up against the die or dies; in the latter case the die or dies may either be moved up against the platen or other supporting means or be kept stationary. Normally the die or dies will descend on to the material from above, though other orientations may also be used. The material acted on by the die or dies is normally somewhat larger in plan than the final product desired, so that a margin of waste material or "flash" is left after application of the die or dies.

The material acted on by the die or dies or otherwise subjected to heat and pressure may comprise either one or more than one layer of the trimmed resilient polyurethane foam. If there are more than one such layer, the peripheral portions of the layers can be bonded together by the action of the die or dies or other pressure-applying means so as to give a unitary or integral product. Also, the die or dies may be made to act on an assembly comprising other components in addition to the layer or layers of trimmed resilient polyurethane foam, and where two or more layers of trimmed resilient polyurethane foam are used there may be one or more additional components interposed between one of the layers and the (or an) adjoining layer; such additional components should not extend outwards so far as to become involved in the peripheral joining of the layers just mentioned, unless they are weldable under the conditions of this joining. The kinds of additional component which may be interposed in this way, particularly when the products to be made are reversible cushions, include the following: cotton or woollen wadding, loose crumb, sheets, slabs, and/or strips of resilient cellular materials (which may be the same material as that submitted to the face-rounding treatment, or some other resilient cellular material), sheets, slabs, strips and/or loose fragments of bonded hair upholstering materials, tension springs or resilient straps stretched across a light frame, helical springs, crepe paper, unbonded hair and other unbonded fibrous materials, and other upholsterers' cushioning materials. Additional components such as those listed immediately above may be employed to modify the physical characteristics of the product and/or reduce its cost.

Other additional components which may form part of the assembly acted on by the die or dies or other pressure-applying means include sheets of covering material. Such sheets may be placed above or below or both above and below the remainder of the assembly (assuming that the assembly is mounted for pressing in a normal horizontal position). The sheets of covering material may, if desired, be coated with an adhesive composition so that by the time the pressing operation is finished they will have become attached, whether with or without the assistance of heat supplied by the pressing equipment, to the remainder of the assembly. If the sheets of covering material are of thermoplastic sheeting, they may similarly be adhered to the remainder of the assembly during the pressing operation, but without the use of a separate adhesive composition, where the adhesive properties of the thermoplastic composition of the sheeting itself suffice for this purpose. The products obtained by the novel method may also, of course, be provided with covers in the ordinary way subsequently to the pressing operation.

Articles suitable for use as life-jacket components and as buoyancy aids generally may be made in accordance with the invention. Such an article suitably has sheets of covering material which are sealed together at their edges and completely enclose the trimmed resilient polyurethane foam, and which are

impermeable to water. The sheets should be of a material which is as resistant as possible to sea-water and hydrocarbon oils; some examples of such materials are certain polyvinyl chloride compositions, diene-nitrile copolymer rubber compositions, and chlorosulphonated polyethylene compositions. Preferably the article comprises several layers of the trimmed resilient polyurethane foam in question enclosed in water-tight compartments formed by interleaved sheets sealed together with the polyurethane foam layers at their edges by dies or the like as previously described; these interleaved-sheets, like the covering sheets, should be of a material which is as resistant as possible to sea-water and hydrocarbon oils. Preferably also the article is divided transversely into water-tight compartments by quilting; the quilting is preferably produced by the application of heat and pressure, as in the case of the rounded edge faces themselves, rather than by stitching.

Where two or more layers of trimmed resilient polyurethane foam are used as described above, they may if desired be of different colours. The use of differently-coloured layers enables interesting decorative effects to be obtained.

It will be appreciated that the novel method affords a particularly simple, quick, efficient, and elegant method of producing reversible cushions and the like consisting basically of trimmed resilient polyurethane foam.

The following examples illustrate the invention.

EXAMPLE 1

This example relates to the production of reversible cushions.

Two thin slabs or sheets of trimmed resilient polyurethane foam, each measuring 1" by 14¾" by 14¾" when not loaded, and having a density of 45 kilograms per cubic metre when not loaded, were laid one upon the other in the centre of the lower electrode of a radio-frequency dielectric-heating pressing apparatus. This lower electrode was flat. A centrally-mounted upper electrode in the form of a brass frame of square outline, having inside dimensions of 12½" by 12½" and a thickness of ⅛" and therefore having an electrode area of about 6¼ square inches, was brought down on top of the two trimmed resilient polyurethane foam sheets, and was pressed on to them under a pressure of 4000 pounds. When the upper electrode was thus pressed down, but not before, the sheets were dielectrically heated for 30 seconds, the apparatus being set for a frequency of about 37 megacycles per second and an initial output of 5½ kilowatts; the apparatus was left at the same setting during the 30 seconds' heating, but at the end of this time the output had fallen to 4¼ kilowatts. After the 30 seconds' heating the upper electrode was raised, and the two sheets were found to have been formed into a single body having doubly-rounded edge faces but also having a surrounding "flash" about one inch wide. This flash was easily removable, however, and was pulled off by hand to leave an article suitable for use as a reversible cushion.

EXAMPLE 2

This example relates to the production of buoyant components of life-jackets.

Four thin slabs or sheets of trimmed resilient polyurethane foam of appropriate outline (one inch large all round than the required size), and having a density of 45 Kg. per cubic metre when not loaded, were laid one upon the other in the centre of the lower electrode of a radio-frequency di-electric-heating pressing apparatus; three sheets of petroleum-resistant polyvinyl chloride composition 8 thousandths of an inch thick and of the same linear dimensions as the trimmed resilient polyurethane foam sheets were placed above, below and in the middle of the stack of polyurethane foam sheets. The lower electrode of the pressing apparatus was flat. A centrally mounted electrode in the form of a reticulated brass frame of appropriate outline was brought down on top of the resilient polyurethane foam and polyvinyl chloride composition sheets and was pressed on to them under a pressure of 6000 lb. When the upper electrode was thus pressed down, but not before, the sheets were dielectrically heated for 70 seconds, the apparatus being set at a frequency of about 37 megacycles per second, and an initial output of 4 kilowatts; the apparatus was left at the same setting during the 70 seconds heating, but by the end of this time the output had fallen to 2 killowatts. After the 70 seconds heating the upper electrode was raised, and the seven sheets were found to have formed into a single, quilted, body having doubly-rounded edge faces but also having a surrounding "flash". This flash was cut off to leave an article suitable for use as the filling of one section of a life-jacket.

The invention is further illustrated in the accompanying drawings, in which:—

Figures 1 to 4 are schematic vertical sections showing various stages in the formation of rounded edge faces on a slab of trimmed resilient polyurethane foam in accordance with the present invention using a high-frequency dielectric pressing apparatus and

Figure 5 is a vertical section through the product resulting from the operations described in connection with Figures 1 to 4.

In the case of Figure 1 the slab of trimmed resilient polyurethane foam 11 has been laid on the lower electrode 12 of the di-electric heating apparatus, the upper electrode of which is shown at 13 with a metal die 14

attached to it. At the stage shown in Figure 2 the upper electrode 13 has been lowered and the die 14 has partially compressed the slab 11 as shown at 15. At the stage shown in Figure 3, the die 14 has fully compressed the slab 11 at 15; it is at this stage that heat is applied. In the case of Figure 4 the upper electrode 13 and the die 14 have been raised again, and rounded edge faces have been left at 15 on the slab 11, there being a margin of waste material or "flash" left beyond 15 as shown at 16. Figure 5 shows the slab 11 after removal of the waste material or "flash", when it may be considered to possess rounded edge face(s) 17 and main faces 18 and 19.

WHAT WE CLAIM IS:—

1. A method of forming a rounded edge face on a slab of trimmed resilient polyurethane foam (as defined above) which comprises subjecting the material to heat and pressure along a line adjacent to said edge face, the pressure being directed substantially normally to a main face of the slab.

2. A method according to Claim 1, in which the pressure is applied through one or more dies having the form of a thin straight or curved metal bar, or a combination of such bars, or a thin-walled metal ring.

3. A method according to either of the preceding claims, in which the die or dies or other means used to apply pressure extend around the entire periphery of the slab of trimmed resilient polyurethane foam.

4. A method according to any of the preceding claims, in which the slab of trimmed resilient polyurethane foam is heated by high frequency di-electric heating.

5. A method according to any of the preceding claims, in which the material subjected to heat and pressure comprises more than one layer of the trimmed resilient polyurethane foam.

6. A method according to Claim 5, in which the peripheral portions of the layers of trimmed resilient polyurethane foam are bonded together by the action of the die or dies or other pressure-applying means.

7. A method according to any of the preceding claims, in which the die or dies or other pressure-applying means act on an assembly which includes sheets of covering material.

8. A method according to Claim 7, in which the sheets of covering material are adhered to the remainder of the assembly during the pressing operation itself.

9. A method of making an article suitable for use as a buoyancy aid, in accordance with any of the preceding claims, in which sheets of covering material are provided which are sealed together at their edges and completely enclose the trimmed resilient polyurethane foam and which are impermeable to water.

10. A method according to Claim 9, in which several layers of the trimmed resilient polyurethane foam are used and these layers are enclosed in water-tight compartments formed by interleaved sheets sealed together at their edges.

11. A method according to either of Claims 9 and 10, in which transverse divisions into water-tight compartments are formed by quilting.

12. A method according to Claim 1, which is substantially as described in either of the examples given above.

13. A method according to Claim 1, which is substantially as described above with reference to the accompanying drawings.

14. An article obtained by a method according to any of the preceding claims.

15. A cushion or other article comprising a slab of trimmed resilient polyurethane foam (as defined above), having an upper main face, a lower main face and an edge face joining the upper and lower main faces and generally convex in cross-section with the apex of the curve at least approximately midway between the upper and lower main faces, characterized by a layer of compressed material lying at the apex of the curve and thus at the middle of the said edge face or slightly offset therefrom.

16. An article according to Claim 15, comprising more than one layer of the trimmed resilient polyurethane foam.

17. An article according to Claim 16, in which the peripheral portions of the layers are bonded together.

18. An article according to any of Claims 15 to 17, provided with at least one sheet of covering material adhered to the remainder of the assembly.

19. An article suitable for use as a buoyancy aid, which is as specified in any of Claims 15 to 18 and which is provided with sheets of covering material which are sealed together with the trimmed resilient polyurethane foam at their edges and completely enclose the trimmed resilient polyurethane foam, and which are impermeable to water.

20. An article according to Claim 19, comprising several layers of the trimmed resilient polyurethane foam enclosed in water-tight compartments formed by interleaved sheets sealed together with the trimmed resilient polyurethane foam at their edges.

21. An article according to either of Claims 19 and 20, which is divided transversely into water-tight compartments by quilting.

C. H. BOWYER,
Agent for the Applicants.

PROVISIONAL SPECIFICATION

# Improvements relating to Articles consisting wholly or partly of Resilient Cellular Materials

We, DUNLOP RUBBER COMPANY LIMITED, of 1, Albany Street, London, N.W.1, a British Company, do hereby declare this invention to be described in the following statement:—

The invention relates to cushions and other articles consisting wholly or partly of resilient cellular materials of the kind which though resilient at ordinary temperatures can be permanently compressed at certain elevated temperatures. Resilient cellular materials which are of this kind include in particular resilient polyurethane foams. By a "resilient polyurethane foam" is meant a resilient cellular material of the kind obtainable by reacting a liquid polyester (or polyester-amide), an organic isocyanate (usually a di-isocyanate), and an activating mixture, which usually contains water, and which may also comprise an emulsifying agent and an activating agent proper (e.g. a tertiary amine). The procedure usually followed in producing resilient polyurethane foam consists in mixing the three materials just mentioned, together with any desired colouring agent, hair or other fibrous material, or other additional constituent, allowing the mixture so formed to foam at ordinary room temperatures and then to set at ordinary room temperatures, and allowing the set foam to mature, either at ordinary room temperatures or at an elevated temperature. In maturing, certain cross-linking reactions which take place between the polyester (or polyesteramide) and the organic isocyanate are completed, and the product develops the desired mechanical properties.

It is an object of the invention to provide a novel method of forming a rounded face on a mass of a resilient cellular material of the kind specified.

According to the present invention, a method of forming a rounded face on a mass of resilient cellular material of the kind specified comprises subjecting the material to heat and pressure along a line adjacent to said face, the pressure being directed substantially parallel to said face.

The invention also includes cushions and other articles made of resilient cellular material of the kind specified, having an upper face, a lower face and a side face joining the upper and lower faces and convex in cross-section with the apex of the curve at least approximately midway between the upper and lower faces, characterized by a layer of compressed material lying at the apex of the curve and therefore at the middle of the said side face or slightly offset therefrom. These articles can be made by method as specified in the preceding paragraph, which have the characteristic that they will form an intermediate compressed layer of the kind just mentioned, this compressed layer extending over the area over which the pressure has been applied.

The pressure applied in the novel method of forming rounded faces on resilient cellular materials of the kind specified may be applied through one or more dies, which may take such forms as a thin straight or curved steel bar, or a combination of such bars, or again a thin-walled steel ring.

It is surprising that the application of pressure in the manner referred to above, i.e. merely along a line, can produce a side face rounded at both edges, but it is a fact that the procedure specified can produce rounded side faces which are almost symmetrical; the cross-sections of the rounded side faces are actually generally similar to the end of an ellipse. Since almost symmetrical rounded side faces can be obtained, the invention is of particular value in that it can be applied to the production of reversible cushions with rounded side faces. In this case the die or dies used to apply pressure extend around the entire periphery of the material from which the cushion is to be formed. Reversible cushions of circular, elliptical or other continuously-curved outline can be obtained using a die in the form of a ring or other closed rectilinear figure, and reversible cushions of square, rectangular, symmetrical trapezium shaped or D-shaped outline can be obtained using a die comprising a number of bars or the like combined into the outline in question.

The resilient polyurethane foam or other resilient cellular material may be heated by high frequency di-electric heating. The heat is normally applied after hte pressure has been applied to the material, and while it is still being kept compressed. The material in question may be supported by a substantially flat platen, and this platen, or any other supporting means used, may either be kept stationary during the pressing operation or moved up against the die or dies; in the latter case the die or dies may either be moved up against the platen or other supporting means or be kept stationary. Normally the die or dies will descend on to the material from above, though other orientations may also be used. The material acted on by the die or dies is normally somewhat larger in plan that the final product desired, so that a margin of waste material or "flash" is left after the application of the die or dies.

The material acted on by the die or dies may comprise either one or more than one layer of the resilient cellular material in question. If there are more than one such layer, the peripheral portions of the layers can be bonded together by the action of the die or dies so as to give a unitary or integral product. Also, the die or dies may be made to act on an assembly comprising other components in addition to the layer or layers of resilient cellular material, and where two or more layers of resilient cellular material are used there may be one or more additional components interposed between one of the layers and the (or an) adjoining layer; such additional components should not extend outwards so far as to become involved in the peripheral joining of the layers just mentioned unless they are weldable under the conditions of this joining. The kinds of additional component which may be interposed in this way, particularly when the products to be made are reversible cushions, include the following: cotton or woolen wadding, loose crumb, sheets, slabs, and/or strips of resilient cellular materials (which may be the same material as that submitted to the face-rounding treatment, or some other resilient cellular material), sheets, slabs, strips and/or loose fragments of bonded hair upholstering materials, tension springs or resilient straps stretched across a light frame, helical springs, crepe paper, unbonded hair and other unbonded fibrous materials, and other upholsterers' cushioning materials. The use of additional components such as those listed immediately above can be of value in modifying the physical characteristics of the product and/or reducing its cost.

Other additional components which may form part of the assembly acted on by the die or dies include sheets of covering material. Such sheets may be placed above or below or both above and below the remainder of the assembly (assuming that the assembly is mounted for pressing in a normal horizontal position). The sheets of covering material may, if desired, be coated with an adhesive composition so that by the time the pressing operation is finshed they will have become attached, whether with or without the assistance of heat supplied by the pressing equipment, to the remainder of the assembly. If the sheets of covering material are of thermoplastic sheeting or textile-fabric-backed thermoplastic sheeting, they may similarly be adhered to the remainder of the assembly during the pressing operation, but without the use of a separate adhesive composition, where the adhesive properties of the thermoplastic composition of the sheeting itself suffice for this purpose. The products obtained by the novel method may also, of course, be provided with covers in the ordinary way subsequently to the pressing operation.

Where two or more layers of resilient polyurethane foam or other resilient cellular material of the kind specified are used as described above, they may if desired be of different colours. The use of differently-coloured layers enables interesting decorative effects to be obtained.

It will be appreciated that the novel method affords a particularly simple, quick, efficient, and elegant method of producing reversible cushions and the like consisting basically of a resilient cellular material.

The following example illustrates the invention.

EXAMPLE

Two sheets of resilient polyurethane foam, each measuring 1" by 14¾" by 14¾" when not loaded, and having a density of 45 kilograms per cubic metre when not loaded, were laid one upon the other in the centre of the lower electrode of a radio-frequency di-electric-heating pressing apparatus. This lower electrode was flat. A centrally-mounted upper electrode in the form of a brass frame of square outline, having inside dimensions of 12½" by 12½" and a thickness of ⅛" and therefore having an electrode area of about 6¼ square inches, was brought down on top of the two resilient polyurethane foam sheets, and was pressed on to them under a pressure of 4000 pounds. When the upper electrode was thus pressed down, but not before, the sheets were di-electrically heated for 30 seconds, the apparatus being set for a frequency of about 37 megacycles per second and an initial output of 5½ kilowatts; the apparatus was left at the same setting during the 30 seconds' heating, but at the end of this time the output had fallen to 4¼ kilowatts. After the 30 seconds' heating the upper electrode was raised, and the two sheets were found to have been formed into single body having doubly-rounded side faces but also having a surrounding "flash" about one inch wide. This flash was easily removable, however, and was pulled off by hand to leave an article suitable for use as a reversible cushion.

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849,774 COMPLETE SPECIFICATION
1 SHEET
This drawing is a reproduction of the Original on a reduced scale.

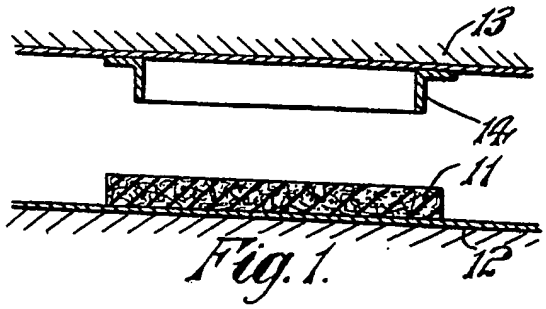


Fig. 1.

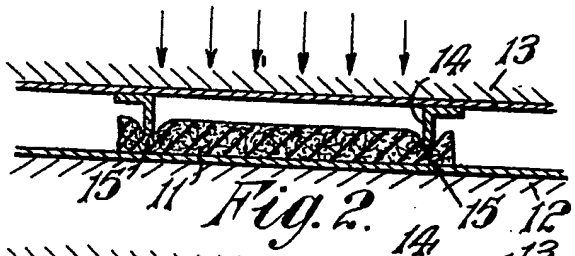


Fig. 2.

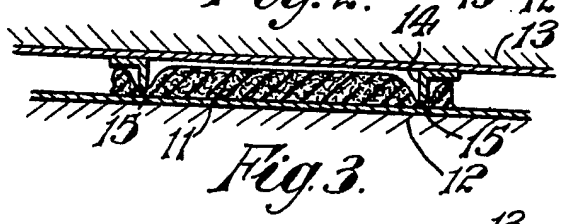


Fig. 3.

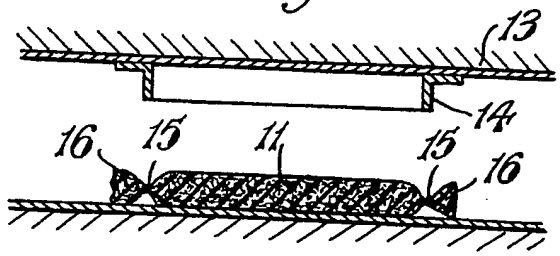


Fig. 4.

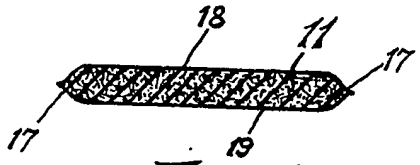


Fig. 5.